Sixty Years of Environmental Radioactivity Research at Risø, Denmark and Future Guidelines

Hou, Xiaolin

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Sixty Years of Environmental Radioactivity Research at Risø, Denmark and Future Guidelines

Xiaolin Hou *
Technical University of Denmark, Center for Nuclear Technologies, Risø Campus, 4000 Roskilde, Denmark
E-mail: xiho@dtu.dk

Abstract

Environmental radioactivity research was initiated in 1956 at Risø, a nuclear research center, located at Roskilde, Denmark, and continues until now. Risø was merged with Technical University of Denmark in 2007, and the research on the environmental radioactivity is now carried out in the Center for Nuclear Technologies. Besides the continuous monitoring the radioactivity level of various anthropogenic and natural occurred radionuclides in various environmental samples, such as aerosol, precipitation, grass, milk, river water and seawater. Fig.1 illustrates the long-term continuous monitoring of anthropogenic radionuclides (^{137}Cs and ^{90}Sr) and natural occurring radionuclides (^{7}Be, ^{210}Pb) in aerosol samples collected at Risø, Denmark.

In the past years, numbers of advanced radioanalytical method for hard-to-measure radionuclides and their speciation have been developed, such as isotopes of actinides (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{236}U, ^{234}U, ^{237}Np, ^{241}Am, ^{243}Cm, ^{244}Cm), ^{99}Tc, ^{129}I, ^{226}Ra, ^{228}Ra, ^{210}Pb, ^{210}Po, ^{3}H, ^{14}C, etc. in various environmental samples for the researches of environmental radioactivity. In addition, automated analytical system using sequential injection approach was developed for rapid separation of various hard-to-measure radionuclides in order to fast measurement of these radionuclides in the environment.

Meanwhile, the environmental and biological behaviors and radioecology of various radionuclides has been investigated, such as the distribution of hot particles in the nature environment of an accident site, bioavailability of actinides in hot particles, exposure and transfer pathway of radioactive particles. Environmental trace studies of radionuclides in marine and terrestrial system have being another hot topic in the past year.

By determination of the long-lived anthropogenic radionuclides such as ^{129}I, ^{236}U, ^{99}Tc, ^{137}Cs, ^{90}Sr in seawater, the interaction of mater mass in the marine system has been studied. Fig. 2 shows the temporal variation of average concentration of ^{137}Cs in surface and bottom seawater in Danish strait (between Atlantic and Baltic Sea), demonstrating the water exchange between the Atlantic and the Baltic Sea. Long-lived anthropogenic ^{129}I has been used for investigation of atmospheric dispersion of volatile pollutions in the atmosphere.

A brief review on radioanalytical methods developed in the paste 10 years, and the research work on the environmental radioactivity, radioecology and environmental trace studies in the past 60 years at Risø, is presented, especially the relevant researches related to the sources of man-made radionuclides that have been considered include global fallout from nuclear weapons testing during the 1960's, local radioactive pollution from an accident in Greenland at Thule in 1968, and fallout from the accident in Chernobyl in 1986 and in Fukushima in 2011 will be discussed. Meanwhile some future guidelines in the research of environmental radioactivity are highlighted.

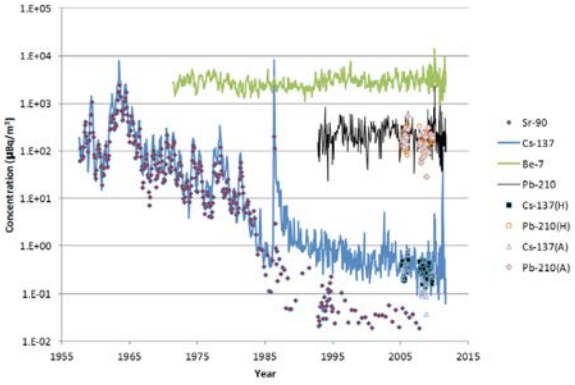

Fig. 1 Long-term monitoring of anthropogenic and natural occurred radionuclides in aerosol at Risø, Denmark

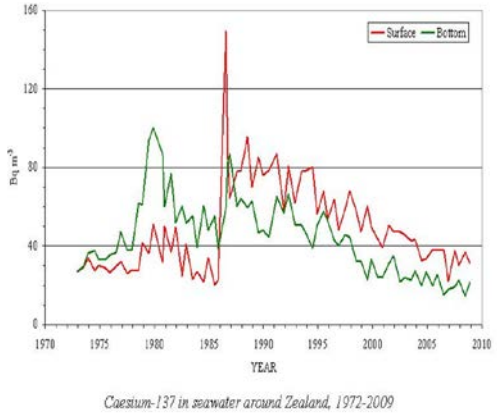

Fig. 1 Temporal variation of ^{137}Cs in Danish seawater

References

Hou X.L., Dahlgaard H., Nielsen S.P., 2001, Chemical speciation analysis of ^{129}I in seawater and a prliminary investigation to use it as a tracer for geochemical cycle study of stable iodine, *Marine Chemistry*, 74:145-155.

Hou X.L., Fogh C.L., Kucera J., Andersson K.G., Dahlgaard H.,, Nielsen S.P., 2003, Iodine-129 and Cesium-137 in Chernobyl Contaminated Soil and Their Chemical Fractionation, *Sci. Total Environment*, 308(1-3):97-109.

Hou X.L., Povinec P.P., Zhang L.Y., Shi K.L., Biddulph D., Chang C.C., Fan Y.K., Golser R., Hou Y.K., Jeskovsky M., Jull A.J.T., Liu Q., Luo M.Y., Steier P., Zhou W.J., 2013, Iodine-129 in Seawater Offshore Fukushima: Distribution, Inorganic Speciation, Sources, and Budget, Environ. Sci. Technol., 47(7):3091-3098.

Hou, X.L., Aldahan, A., Nielsen, S.P., Possnert, G., Niels, H., Speciation of ^{129}I and ^{127}I in seawater and implications for sources and transport pathways in the North Sea, Environ. Sci. Tech., 2007, 41, 4993-5999.

Nielsen S.P., Roos P., Thule 2007 – Investigation of radioactive pollution on land, Risø-R-1781(EN)

Qiao J.X., Hou X.L., Steier P., Golser R., 2013, Sequential Injection Method for Rapid and Simultaneous Determination of ^{236}U, ^{237}Np, and Pu Isotopes in Seawater, Anal. Chem., 85(22), 11026-11033.

Qiao J.X., Shi K.L., Hou X.L., Nielsen S.P., Roos P., 2014, Rapid multi-sample analysis for simultaneous determination of anthropogenic radionuclides in marine environment, Environment. Sci. Technol., 48:3935-3942.

Qiao J.X:, Hou X.L., Steier P., Nielsen S., Golser R., 2015, Method for ^{236}U determination in seawater using flow injection extraction chromatography and accelerator mass spectrometry, Anal. Chem., DOI: 10.1021/acs.analchem.5b01608

Shi K.L., Hou X.L., Qiao J.X., Sun X.J., Roos, P., Wu W.S., 2016, Analysis of Technetium Species and Fractions in Natural Seaweed Using Biochemical Separation and ICP-MS Measurement, Anal. Chem., 88(23), 11931-11937.

Shi K.L., Hou X.L., Roos P., Nielsen S.P., 2013, Seasonal variation of technetium-99 in Fucus vesiculosus and its application as an oceanographic tracer, Estuarine Coastal and shelf Science, 127:24-28.

Zhang L.Y., Hou X.L., Xu S., 2015, Speciation analysis of ^{129}I and ^{127}I in aerosol using sequential extraction and mass spectrometry detection, Anal. Chem., DOI: 10.1021/acs.analchem.5b01555.

Zhang, L.Y., Hou, X.L., Xu, S., 2016, Speciation of ^{127}I and ^{129}I in atmospheric aerosols at Risø, Denmark: Insight into sources of iodine isotopes and their species transformations. Atmos. Chem. Phys. 2016, 16:1971–1985.